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A. D. MELVIN, Chief of Bureau.

WASHINGTON, D. C., December 2, 1905.

SIR: The accompanying article, entitled "Blackhead, or Infectious Enterohepatitis, in Turkeys," was written by Dr. Veranus A. Moore, then Chief of the Division of Animal Pathology of this Bureau, and published in 1896 as Circular No. 5 of the Bureau series. There is a continued demand for information regarding this disease, and the article has accordingly been revised by Dr. John R. Mohler, of this Bureau, and it is recommended that it be republished as Bureau of Animal Industry Circular No. 5 (revised).

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

BLACKHEAD, OR INFECTIOUS ENTERO-HEPATITIS, IN TURKEYS.

The organs from diseased turkeys received at this laboratory during the last ten years show that infectious enterohepatitis (blackhead) of turkeys is not restricted, as formerly supposed, to the States bordering on the New England coast, but that certain flocks in the Middle, Southern, and Western States are affected with it. The data obtained bearing upon the geographical distribution of the disease indicate that it is gradually extending into the Western States, and accounts have also been received of its occurrence in Europe. For want of statistics the amount of loss to the poultry industry occasioned by this disease can not be accurately estimated, but the fact that it has caused many farmers and poultry men in New England to discontinue the raising of turkeys shows that it is of much economic importance. It is stated in the report of the Rhode Island Agricultural Experiment Station for 1894 that "the eradication of this disease would be worth hundreds of thousands of dollars to the eastern farmers alone." These heavy losses in the East, together with the accumulating evidence that many sections of this country are sprinkled with infected districts from which the disease is spreading, render the determination of the means by which this dissemination occurs a matter of more than ordinary significance to those engaged in the turkey industry.

NATURE OF THE DISEASE.

Prior to 1894 the nature of this disease was unknown. In the fall of 1893 Prof. Samuel Cushman, of the Rhode Island State Experiment Station, sent a few specimens of the diseased organs of turkeys which had died of blackhead to this laboratory, where they were carefully examined by Dr. Theobald Smith. In the summer of 1894 Dr. Smith made a careful study of this disease at the Rhode Island Experiment Station. He found that it was caused by one of the protozoa (*Amœba meleagridis* Smith), and he published¹ a full description of the

¹An Infectious Disease Among Turkeys Caused by Protozoa (Infectious Enterohepatitis). (Bulletin No. 8, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C., 1895.)

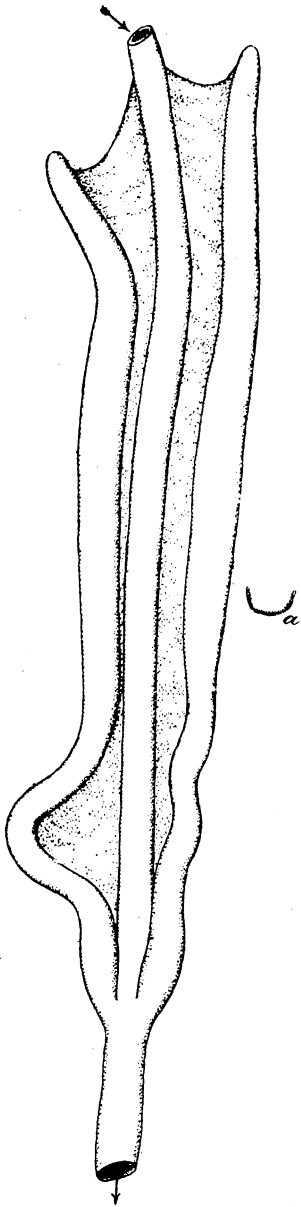


FIG. 1.—Ceca of healthy turkey weighing about 7 pounds. The central tube is the small intestine, the food passing downward in the direction of the arrow. At the junction of the ceca with the intestine, the food is drawn into the ceca by suction. The thickness of the cecal wall is shown in *a*.

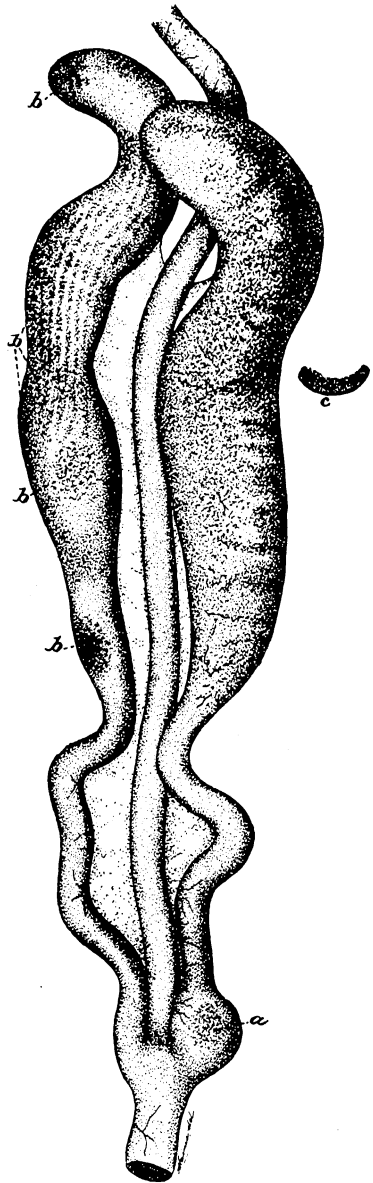


FIG. 2.—Ceca of turkey No. 7, in which the protozoan disease was produced. The upper two-thirds of one cecum is affected; also an area, *a*, near the union with the colon. The other cecum is thickened at the points *b*. The thickness of the affected cecal walls is shown in section *c*. (Reduced one-third.)

disease, which, in accordance with the lesions, he designated infectious enterohepatitis.¹ This report shows that the disease usually attacks the young turkeys. The walls of one or both ceca become thickened, and the liver is mottled with areas of varying size, having a brownish, yellowish, or perhaps greenish color. These peculiarly colored areas in the liver are of diagnostic value, as they have not been found in other cecal or intestinal troubles. The microscopic examination of the affected parts showed the presence of large numbers of the protozoa in the cells and intercellular tissue. The life history of this parasite and the way by which the turkeys become infected with it were not determined, but, from the facts elicited, Dr. Smith² thought it highly probable that the microorganism is transmitted from turkey to turkey without passing through an intermediate host.

The nature of the disease indicates that inquiries into the means by which it is transmitted, with the object of determining methods for its prevention, promise more speedy and practical results than investigations into its medicinal treatment. Furthermore, it is of much importance that its spread into noninfected localities should be checked. To accomplish this, it is first necessary to demonstrate whether the specific microparasite is, as supposed by Dr. Smith, directly transmitted from turkey to turkey by feeding from the ground soiled by the feces of affected turkeys. It is the opinion of many turkey raisers that the disease is contracted either by eating certain insects or by drinking from stagnant pools.

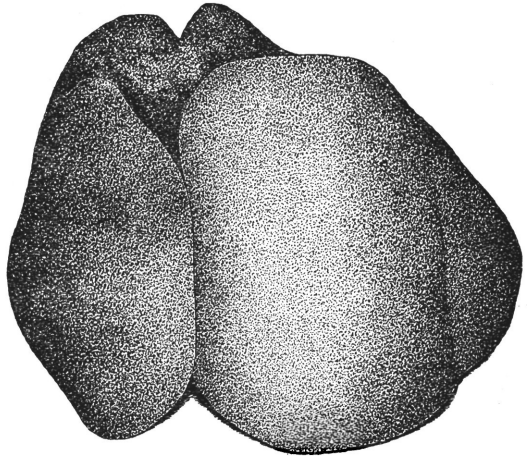


FIG. 3.—Liver of a healthy turkey weighing about 7 pounds.

In October, 1895, a special inquiry was made into the conditions under which the disease occurs in Rhode Island, for the purpose of arranging experiments to determine the source of infection and the transmissibility of this affection.

It was learned that there was much less of this disease among turkeys in the summer and fall of 1895 than there had been in previous years. The statement was also made by a large number of turkey raisers that an unusually large number of old turkeys had died in the spring of 1895. This clinical history suggested the possibility that many of the old turkeys which were affected with a chronic form of the disease had succumbed in the spring, thus cutting off the

¹The popular term "blackhead" refers to the darkened appearance of the heads of the turkeys affected with this disease. This symptom also occurs in cases of other intestinal troubles of turkeys.

²Concerning the transmission of this disease, Dr. Smith makes the following statements: "From our present standpoint I think it safe to assume that the microparasite is transmitted from bird to bird without passing through any intermediate host. The microparasite, discharged perhaps in an encysted stage from the sick bird, is taken up with the food and water by others and sets up the disease directly. If the parasites were taken up with insects, for example, we should expect to find the disease diffused through all the flocks. But even the limited experience of last summer leads me to believe that certain flocks only are infected, and that by uninterrupted transmission the disease becomes perpetuated and diffused among the neighboring flocks. The perpetuation of the parasites, I am inclined to think, is to be sought for in the older turkeys, which carry them in their bodies, most likely in the digestive tract, during the winter. This view is supported by the fact that turkeys not infrequently recover from the disease. This recovery does not mean, however, the destruction of the parasite within the body, for we have now information concerning the persistence of a variety of parasites—bacteria and protozoa—within the body long after recovery."

channel through which the young might otherwise have become infected later in the season.

The distribution of the disease in Rhode Island was found to be somewhat peculiar, as there were many localities in which it had never been known to occur. From the statements of the farmers, however, it appears that these noninfected districts were gradually invaded, and that occasionally the disease appeared on a farm within the territory supposed to be exempt. Professor Cushman stated that on many farms turkeys were raised without loss, while the flocks on those a mile distant were seriously affected. Several farmers stated that they had raised turkeys for years without suffering from the disease, but that soon after it appeared in their neighbors' flocks it could not be kept out of their own.

Another feature worthy of consideration is the appearance of the disease on farms where turkeys had not been kept for several years prior to the present effort to raise them. In one instance the owner reported that turkeys had not been kept on the place for eleven years prior to 1893. In the spring of that year a few turkeys were purchased from a flock supposed to be perfectly healthy. In the fall a few of the young turkeys died of blackhead. The following year

a larger number of deaths occurred, and at the time this farm was visited at least 80 per cent of a large flock was affected. The examination of a few turkeys which had died during the preceding few days confirmed the accuracy of the diagnosis. It should be remembered that turkeys are prone to wander, and it is highly probable that the first birds which had the disease in 1893 became infected, if the stock was healthy, from turkeys on neighboring farms where the disease did exist, and

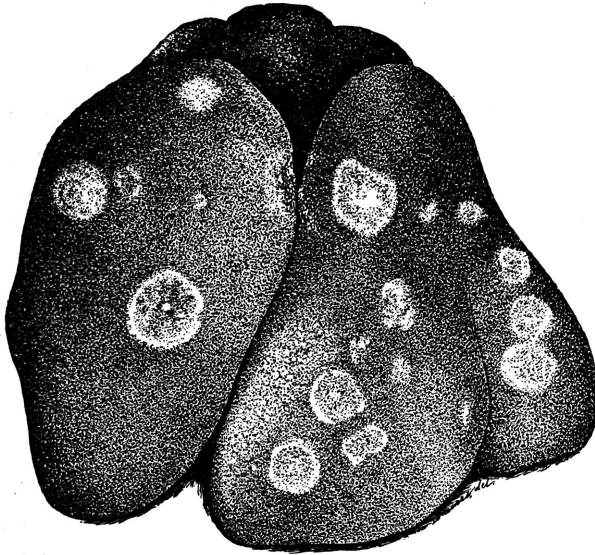


FIG. 4.—Produced protozoan disease. Liver of turkey No. 5, showing discolored areas, or spots. (Reduced one-third.)

that one or more of the infected birds were wintered, thus establishing the disease in the flock. A similar history was obtained from other farmers. While other means of transmitting the microparasite are possible, the facts elicited concerning the appearance of the disease in a large number of flocks could be explained on the hypothesis of the direct transmission of the parasite.

A feeding experiment with the excrement and viscera of diseased turkeys was arranged late in November, 1895. The statement that it was practically impossible to recognize the disease in the spring rendered it desirable to make the initial experiment early in the winter, notwithstanding the fact that nearly adult turkeys would have to be used for the exposure. Through the efforts of Professor Cushman, three presumably affected turkeys were obtained. Dr. E. C. Schroeder secured in the District of Columbia healthy turkeys about five months old, each weighing from 6 to 8 pounds. With these turkeys the following feeding experi-

ment was conducted at the experiment station of the Bureau, under the immediate supervision of Dr. Schroeder :

FEEDING HEALTHY TURKEYS WITH THE EXCREMENT AND VISCERA OF TURKEYS
AFFECTED WITH INFECTIOUS ENTERO-HEPATITIS.

November 27, 1895, three turkeys (Nos. 1, 2, and 3) were received from Rhode Island.

Turkey No. 1 was dead upon arrival. The post-mortem examination showed extensive lesions characteristic of the protozoan disease. Sections of the affected organs revealed the presence of the specific parasite.

Turkey No. 2 died during the night of December 1. It exhibited lesions similar to those found in turkey No. 1.

Turkey No. 3 appeared to be sick upon arrival, but soon improved and at this writing is apparently well.

The living turkeys were taken to the experiment station November 28. As one of the turkeys was dead upon its arrival, it was decided to divide the experiment into two parts, namely, (1) feeding the liver and ceca of the dead turkeys to healthy ones, and (2) exposing healthy turkeys in a small yard to the surviving Rhode Island turkeys. In order to be sure that the healthy turkeys ate the food soiled with the excrement from the sick ones, the affected birds were separated at night and their feces collected and thoroughly mixed with the corn and wheat fed to the well ones on the following day.

Two healthy turkeys (Nos. 8 and 9) were fed the liver and ceca of turkeys Nos. 1, 2, and 12.¹ The affected organs were chopped into fine pieces, mixed with the food, and fed daily in small quantities until consumed. The dates of feeding the viscera are as follows:

November 28,² Turkeys Nos. 8 and 9 fed liver and ceca of turkey No. 1.

December 3. Turkeys Nos. 8 and 9 fed liver and ceca of turkey No. 2.

January 3, 1896. Turkeys Nos. 8 and 9 fed liver and ceca of turkey No. 12.

Autopsy notes.—Turkey No. 8 was found dead January 11. The liver contained several small areas of a yellowish color. One cecum was enlarged and the serous surface sprinkled with several quite large areas covered with a grayish exudate. The cecal wall was thickened and the mucosa necrosed over several areas. Contents of a semiliquid nature and blood-stained. The other cecum was normal. The disease in the cecum and liver was very acute. The protozoa were found in the thickened cecal wall.

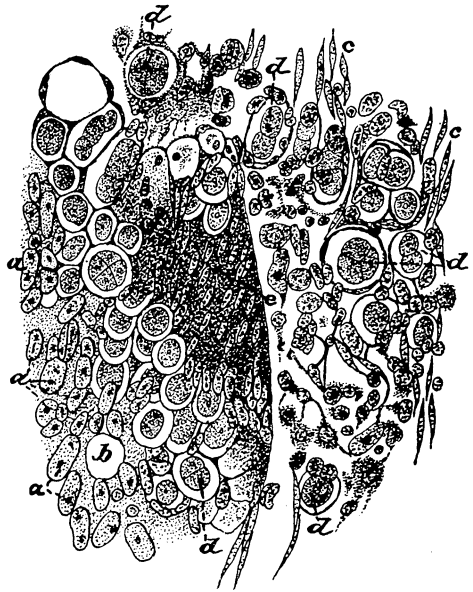


FIG. 5.—A portion of the mucous membrane of an affected cecum cut transversely. *a*, Nuclei of epithelium. *b*, Mucin represented by a cavity in the section. *c*, Spindle-shaped cells belonging to the interlobular tissue. *d*, Protozoa, single and in compact groups, situated within the meshes of the reticulum. *e*, Multinucleated (giant) cell which has enveloped some of the protozoa. (After Smith.)

¹Turkey No. 12 was one of a lot of diseased turkeys received from Professor Cushman early in January, 1896.

²These are the dates upon which the feeding began, but the consumption of all the material required from two to three days in each case. It should be stated, however, that very little, if any, of the viscera of the first case was eaten.

Turkey No. 9 appeared to be well January 13 and was killed for examination. The ceca were normal, but the liver was sprinkled with a large number of small (one-half to 2 mm. in diameter) gray, brown, and greenish colored areas. Sections of the liver showed excessive fatty degeneration, but the specific organism of the protozoan disease was not found.

In the other part of the experiment four healthy turkeys (Nos. 4, 5, 6, and 7) were penned November 28 with the two surviving Rhode Island turkeys (Nos. 2 and 3). They were also fed daily, beginning November 29, upon the excrement of turkeys Nos. 2 and 3 for three days, when turkey No. 2 died. For two weeks subsequently they received in their daily rations the feces dropped during the previous night by turkey No. 3. The outcome of this exposure was as follows:

Turkey No. 4 died December 20, 1895, of infectious entero-hepatitis.

Turkey No. 5 died December 25, 1895, of infectious entero-hepatitis.

Turkey No. 6 killed January 13, 1896, not apparently affected.

Turkey No. 7 killed January 13, 1896, extensive lesions of infectious entero-hepatitis.

Autopsy notes.—Turkey No. 4 died of the protozoan disease during the night of December 20. The liver was sprinkled with several areas of a yellowish brown color 4 to 12 mm. in diameter. The intervening tissue closely sprinkled with grayish points. The mucosa of the duodenum and ileum hyperemic. The walls of the ceca were thickened and agglutinated together. The mucous membrane of the ceca was hyperemic, with several quite large areas over which the mucosa was necrosed.

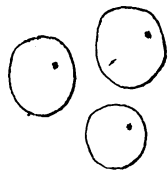


FIG. 6.—The protozoan parasites as they appear in crushed and teased fresh tissue, magnified 1,000 diameters. (After Smith.)



FIG. 7.—Protozoan occupying space formerly occupied by liver cells. Much enlarged. (After Smith.)

Turkey No. 5 died late in the afternoon of December 25. It was examined December 26. The liver contained several areas of necrosed tissue of a yellowish brown color. The walls of the ceca were very much thickened and agglutinated together and to adjacent portions of the intestine. Protozoa were found in sections of the ceca.

Turkey No. 6 appeared to be well January 13. It was killed for examination. The organs were normal in appearance.

Turkey No. 7 appeared well and in good flesh January 13. It was killed for

examination. The liver contained many yellowish and brown areas. The walls of both ceca were thickened. The serosa of one cecum was covered with a thin grayish exudate. Blood vessels injected. This turkey would undoubtedly have died of the protozoan disease within a few days.

The absence of the disease in the turkeys used in this experiment is assured by the fact that Dr. Schroeder witnessed the killing and carefully examined the viscera of six other turkeys from the same flock, all of which were perfectly normal. In addition to this, the disease had not been found at that time in the District of Columbia or in the States of Maryland and Virginia. In February, 1895, Dr. Smith examined the ceca of about thirty turkeys from the Washington market without finding the disease, and in the fall of the same year a number of others from the same source were examined by Dr. Moore with similar results.

The disease in each of the four undoubted cases (turkeys Nos. 4, 5, 7, and 8) of the protozoan disease produced by feeding was similar to that found in the turkeys described by Dr. Smith in both the nature and the distribution of the lesions. The lesions were more recent than those found in Rhode Island, indicating that the produced disease was more acute than when it occurs under more natural conditions. The liver of turkey No. 9 indicated the early stage of an extensive invasion, although the presence of the microparasite was not demonstrated. The absence of the disease in one of the turkeys (No. 6) fed with the feces is not difficult to explain. It must be remembered that the

four turkeys (Nos. 4, 5, 6, and 7) were fed feces of but one turkey (No. 2) known to have had the disease, and with these for only three days. Turkey No. 3 appears not to have been affected, and it was not sacrificed to determine this point, as it was desired to demonstrate, if possible, the disease in old turkeys in the spring. The fact that four typical cases of the disease were produced is ample evidence of the direct transmission of the parasite. It is also important to note that in this experiment the disease was produced in nearly adult turkeys.

Other experiments are being made to test the efficiency of disinfectants and the length of time the micoparasite will remain alive in the feces. It is now definitely known that wild turkeys and chickens are affected with this disease, and the communicability of the malady to other species is being tested.

SUGGESTIONS CONCERNING PREVENTION.

The practical teaching of the above experiment is obvious. If the method of direct infection proves to be the only means of transmission, the extermination of the disease is possible. It is impossible, however, to give positive directions concerning the management of diseased flocks, or at present healthy ones, within the infected localities, until further facts are obtained relating to infection other than from turkey to turkey. The practical solution of this question rests largely in the future experience of those farmers who eliminate the possibility of direct infection. From our present knowledge of the transmission of the disease, it is suggested that farmers and poultry raisers who have recently had this disease in their flocks should dispose of their old turkeys and start with turkeys obtained from noninfected districts or by hatching turkey eggs under hens. Better results will be obtained by placing the eggs under the hens for twenty-five days, and then by completing their incubation in artificial incubators. The Rhode Island Experiment Station suggests that turkeys may be reared on lands where uninfected turkeys or chickens have been kept if one starts with eggs or turkeys hatched in incubators and artificially brooded. If it is not certain that such eggs come from uninfected stock, they should be sterilized prior to their incubation by washing with a cloth saturated with 95 per cent alcohol. By keeping young turkeys on disinfected board floors until several weeks old, much better success will be attained than if placed at once on the ground. The adoption of this method by the Rhode Island Experiment Station with two lots of turkeys placed subsequently in pens in some woodland has resulted in no losses in one lot and only four in the other, which were undoubtedly affected previously.

As a precautionary measure, the turkey roosts, especially the accumulated droppings, should be disinfected early in the spring before the young turkeys are hatched or old ones introduced. The liberal use of slaked lime in the yards most frequently occupied by the diseased turkeys is recommended. A serviceable disinfectant for buildings and places containing the feces of diseased turkeys is the following:

Crude carbolic acid	one-half gallon.
Crude sulphuric acid	one-half gallon.

"These two substances should be mixed in tubs or glass vessels. The sulphuric acid is very slowly added to the carbolic acid. During the mixing a large amount of heat is developed. The disinfecting power of the mixture is heightened if the heat is kept down by placing the tub or glass demijohn containing the carbolic acid in cold water while the sulphuric acid is being added. The resulting mixture is added to water in the ratio of 1 to 20. One gallon of mixed acids will thus furnish 20 gallons of a strong disinfecting solution having a slightly milky appearance. It is quite corrosive, and care should be taken to protect the eyes from accidental splashing."

Medical treatment has not been sufficiently efficacious to warrant its adoption in any but exceptional cases or in mildly affected birds of a flock that has been recently infected. In such cases, or where it is desired to prevent the affection in healthy birds, Salmon recommends benzonaphthol 1 grain, salicylate of bismuth 1 grain or hyposulphite of sodium 3 grains, twice a day for birds weighing 4 or 5 pounds.

It is hoped that the results of experiments now under way here and at the experiment station of Rhode Island will enable definite and positive answers to be given to many pending questions, especially those concerning the duration of the vitality of the specific microparasite in feces and soil, the use of disinfectants, and whether infection takes place in the absence of diseased turkeys.

It is important that care should be taken not to spread the disease by transporting affected turkeys from an infected locality to a noninfected one. The history of the disease indicates that it has thus become so widely disseminated. Until the life history of the parasite is determined it is impossible to say that this is the only cause of its appearance in different localities. Pending the results of investigations now in progress, it is of the highest importance that the communicability of this disease through the excrement of diseased turkeys should be recognized and vigorous measures adopted to prevent its further spread by this means. Even if other sources of infection be found, future investigations will doubtless prove that the great majority of the turkeys attacked become infected through the direct transmission of the parasite.